T O W N o f B R O O K L I N E
Massachusetts
Park and Recreation Commission

Brookline's Athletic Playing Field Deficit Challenge:
Combined Solution Summary and Turf Frequently Asked Questions (FAQ's)

Brookline's Athletic Playing Field Deficit

Currently, Brookline has a deficit of athletic fields. An increased inventory of athletic field space is required to meet the specific athletic and fitness needs of the community. The athletic fields in Brookline see nearly 30,000 hours of regular scheduled use over the course of a given year, not including additional usage by the Green Dog off-leash program, or walk-in, casual usage. Many groups are turned away each year and permit requests denied due to lack of athletic field space. With a total of 25 athletic fields, 17 are designated as diamond ball fields and eight are designated as rectangular fields. These athletic field resources are located at a total of 18 parks. Nearly all of these fields have overlapping outfields or overlay sports that are played in the outfield or have multiple sports per season. Many fields are significantly undersized or non-conforming and do not meet industry standard for size, and should not be evaluated as though they are full-sized athletic fields.

Demand for fields has risen with the popularity of youth and adult sports. Field user groups, including K-8 schools, high school athletic programs, recreational adult and youth sports programs, camps, and community members express dissatisfaction with the quantity, quality, and access to existing playing fields in the community. These athletic field play areas range from small or irregularly sized grass spaces that support recess, practices, or recreational level programs to standard sized fields that support high school competitive level sports. All of these fields, while different in character, value, and quality, are important to and satisfy (to varying degrees) different user groups for their intended recreational pursuits. Of the 122 field uses of Brookline's athletic fields listed in the ***2020 Athletic Fields Needs Assessment and Master Plan***, 49 of the field uses do not meet regulation size for the sport for which they are utilized. The Plan was created in order to provide a comprehensive 20-year vision, recommendations, and framework for decision-making regarding athletic field management, maintenance, staffing, design, funding, policy, land acquisition, permitting, programs, and partnerships based on community input. The document analyzes Brookline's citizen needs and priorities as they relate to current and potential athletic field inventory, use, design, maintenance, permitting, and programming.

The common perception has been that Brookline's poor athletic field condition has been caused by a shortage of staffing and a lack of proper equipment to maintain these fields. The analysis conducted by the Town's Master Plan consultant team determined that while additional staffing and equipment is necessary, the poor athletic fields condition is a result of overuse of fields, lack of time for fields to rest and regenerate, and lack of regular field renovation (which requires 2 growing seasons of downtime). Since the acquisition or conversion of land is difficult in Brookline, the consultants recommended a combination of natural grass and synthetic turf to meet the demand. Most participants agree that a high quality natural grass athletic playing field is the preferred alternative, however due to the overuse there are situations that warrant consideration of synthetic turf. Synthetic turf fields can provide three times the usage of natural grass fields, can be played on during or immediately following wet weather and do not require downtime to rest or rehabilitate. The Master Plan recommends the following to meet the Town's need for athletic field space:

- 4 new multi-purpose synthetic turf fields to accommodate regulation sized soccer - lighted
- 2 converted multi-purpose synthetic turf fields to accommodate regulation sized soccer - lighted
- 2 new full-size natural grass baseball diamonds - 1 lighted
- 2 men's softball natural grass fields – 1 lighted
- 4 natural grass little league fields

The Town recognizes the importance of existing and future quality athletic field space to meet the recreational needs of the community. Athletic fields, facilities, and programs help support livable lifestyles and communities. Well-maintained, inclusive, accessible, and quality athletic fields and programming have many benefits:

- Strengthen community image and sense of place
- Support economic development
- Strengthen safety and security
- Promote health and wellness
- Foster human development
- Increase diversity and inclusion unity
- Facilitate community problem solving
- Provide competition and recreational experiences

Natural Turf and Synthetic Turf Athletic Field Systems

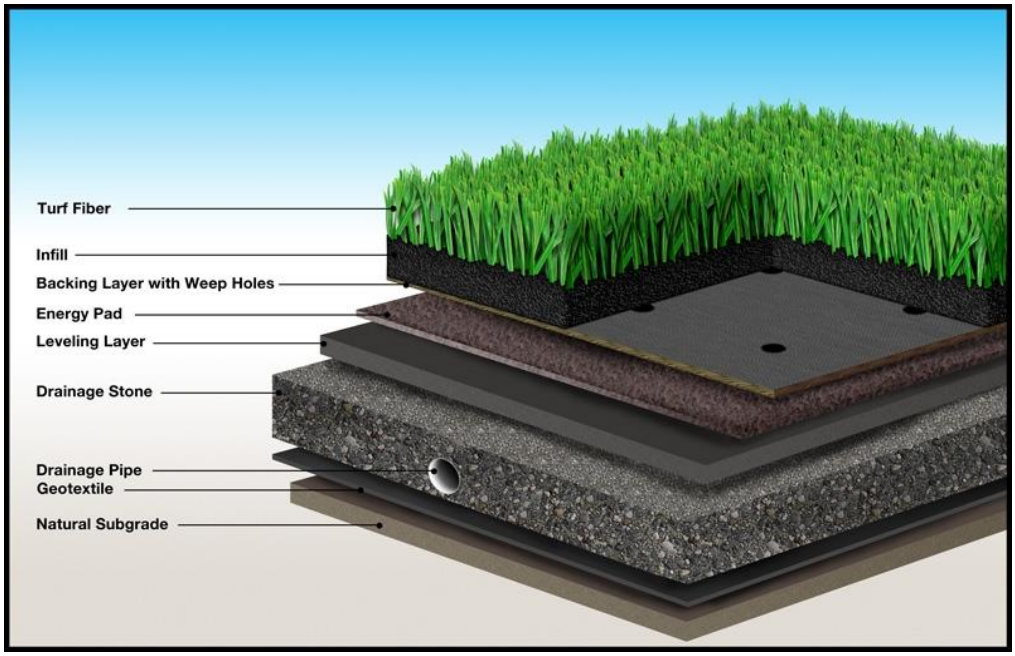
The continued reliance of natural turf fields, under the current allotment of fields available, will continue to be problematic due to the current over-usage of athletic fields and lack of available time to adequately rest the fields and perform proper seasonal maintenance. Additional synthetic turf fields with lighting could accommodate many more activities in Brookline, extend the playing seasons and improve overall playability; synthetic turf field systems can withstand expanded use from players in most weather conditions during the spring and fall sports season. Implementation of synthetic turf field systems has been a popular solution in many communities to address this issue. In Brookline as in all of New England, the greatest challenge occurs in the spring, when high school and other spring sports start in the middle of March, when fields are often still quite wet from recent winter conditions. This, coupled with growth cycles of cool season grasses (those species of grass that are typical to New England), makes the playability of field surfaces in the spring quite challenging. Much of this is directly related to the ambient air and soil temperatures necessary to grow grass.

While synthetic turf fields have provided reliable recreational opportunities for millions of student athletes and adults across the country, there is much controversy about their use ranging from

health impacts to impacts on climate and the environment. Many FAQ documents on the subject are available, including on the Mass.gov website (see https://www.mass.gov/service-details/artificial-turf-fields). The Environmental Protection Agency (EPA), the Consumer Product Safety Commission (CPSC), and other such agencies also have focused FAQs relative to synthetic turf, though they are more focused on the use of crumb rubber infill (see https://www.epa.gov/chemical-research/tire-crumb-questions-and-answers). In recent years, Brookline has committed to ***not*** utilizing crumb rubber infill as a component of any new or replacement synthetic turf fields. As the town continues to renovate existing natural and synthetic turf fields and consider future fields, the following turf FAQs have been developed by Town Staff to highlight and respond to often-asked questions and turf issues specific to Brookline.

Frequently Asked Questions

- ***What is a synthetic turf/ artificial turf field?***
  A *synthetic turf field* and an *artificial turf field* are the same. The preferred terminology in the sports field industry is "*synthetic turf field*". A synthetic turf field is a designed athletic field system that uses a manufactured synthetic turf playing surface. Synthetic fields are designed for continuous play regardless of weather conditions. These field systems typically include a synthetic turf surface combined with an infill material that fills in the voids between the synthetic turf fibers, most often comprised either of rubber and sand or organic material and sand. The infill provides the desired level of resiliency, a key safety feature of any field - natural or synthetic. Currently, there are more than a dozen infill options. The synthetic turf surface itself is created from synthetic fibers, called yarns, typically made from either nylon, polypropylene, polyethylene, or a combination thereof, and manufactured to have an appearance like natural grass. Like household carpeting, these fibers are typically woven and attached to a backing material. In some newer turfs, such as woven turf, face and base yarns are woven together with no separate backing. Below is a typical cross section of a synthetic turf field.



Typical cross-section of a synthetic turf field (each component shown not necessarily utilized in every field) (https://www.syntheticturfcouncil.org/page/FAQs)

- ***What is a natural turf field?***
  A *natural turf field* is a designed system that uses natural grass as the playing surface, with a natural soil system (typically some combination of native loam and sand and/or a manufactured root zone mix in the case of high-performance fields) beneath. Our New England climate limits early spring playability when roots and shoots of grass are coming out of winter dormancy. During the early spring, most of our fields are saturated and the turf has not yet "woken up" from winter dormancy. Making use of a field before it is ready to support use can cause significant damage and inhibit the quality and vigor of turf for the balance of the year. Natural turf provides excellent play surfaces when in top condition, but they are not designed to take continuous play throughout the athletic season, especially during early spring, late fall, and during/after significant rain events. Town of Brookline fields are highly programmed and expected to support continuous use, and this often results in less than favorable playing conditions. The graph below indicates why natural turf field use is challenging in the context of our local climate and Brookline's sports seasons. The ideal grass-growing temperature range is 65°-75° F, which historically occurs later in the spring sports season.

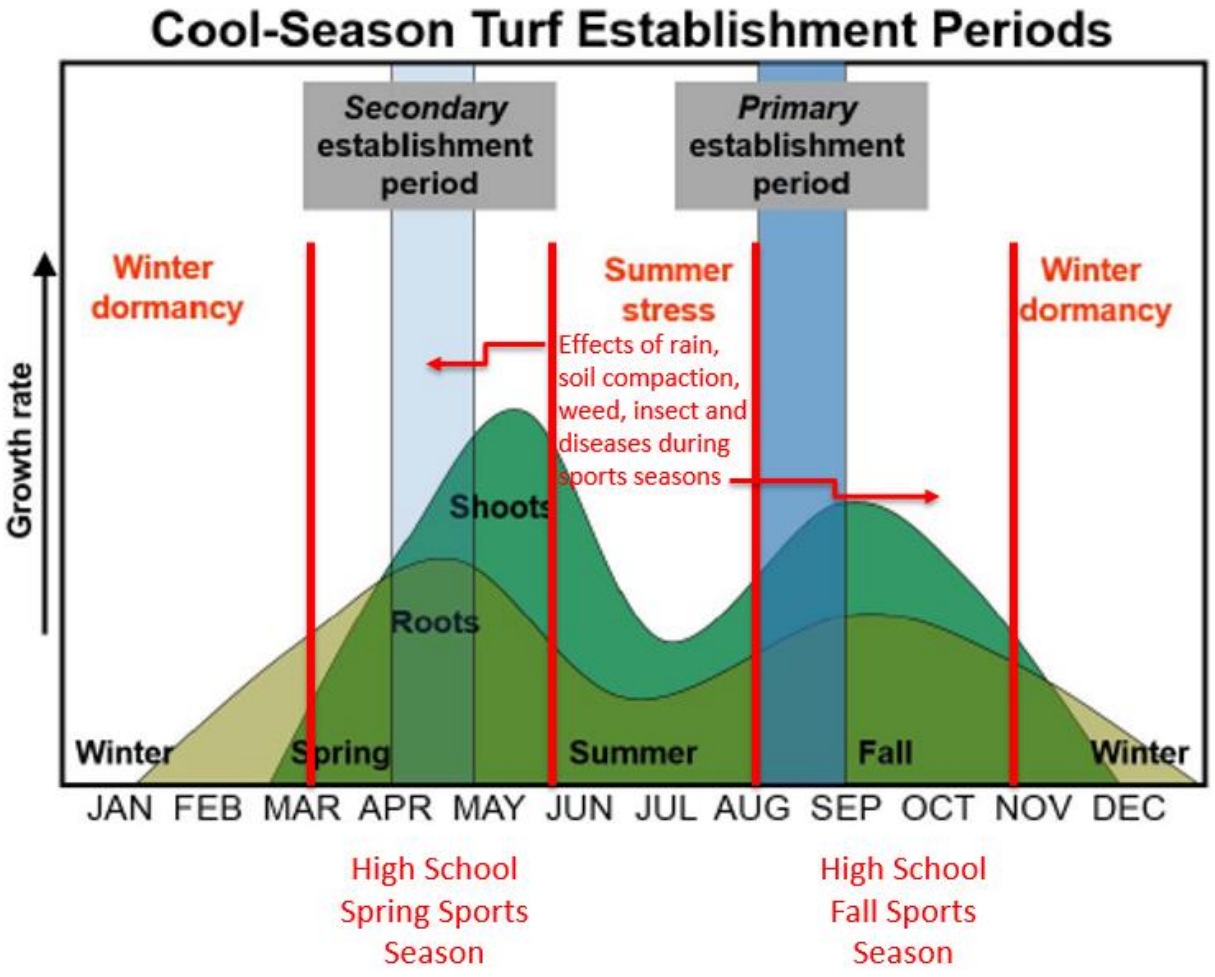
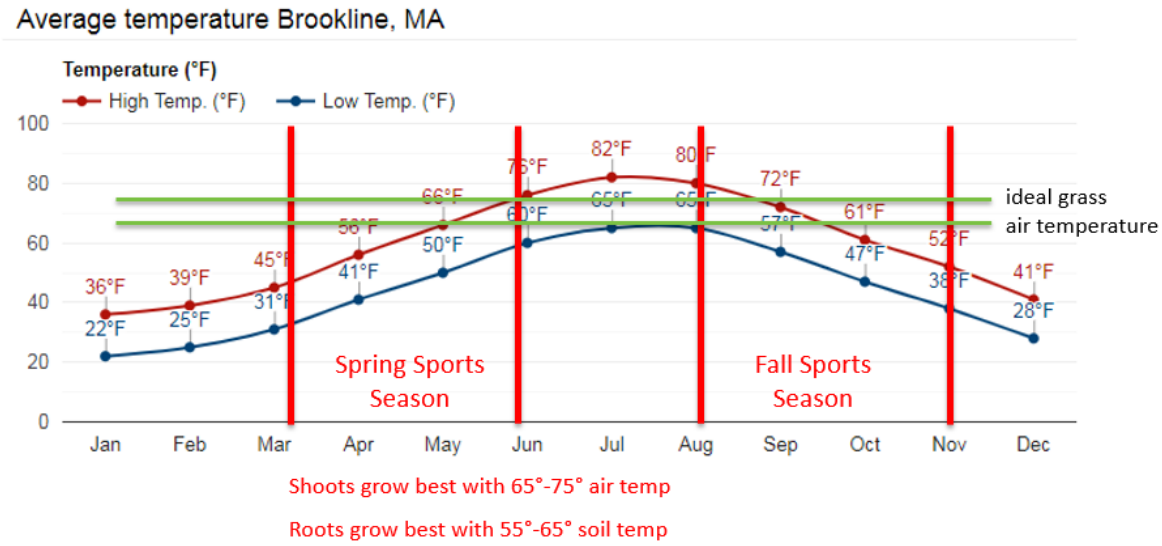


Figure demonstrating Cool Season turf establishment periods. "Cool season" turf refers to grass species grown in New England. This typical Turf Establishment cycle is shown with Spring and Fall High School sports seasons.

- ***Why is synthetic turf used for athletic fields?***
  In our geographic area, synthetic turf fields allow for early spring and late fall play (often referred to as the "shoulder seasons"), while also allowing continuous use during and after rain events. Synthetic turf fields provide all-weather athletic performance, intended to withstand extended and intense use without a need for downtime to recover. Underneath the turf, the subsurface of these fields is most often designed with a layer of crushed stone and sub-drainage piping, which allows the overall system to store, absorb, infiltrate, and transport far greater amounts of precipitation compared to a natural turf field.

  Synthetic turf fields are typically the "work horses" of a municipality's overall athletic facility resources. They are used to increase hours of play, extend seasons of play (especially in the early spring and late fall), and provide a consistent playing experience across the entire field in varying climatic conditions. The benefits of extended hours of use, longer months of play, and greatly-reduced, resource-intensive maintenance have led nearly every community in eastern Massachusetts to construct one or more synthetic turf fields. These fields help meet the demands of the recreational community with reliable and safe conditions for play.



Graph indicating average Brookline temperatures with spring and sports season overlays

The above diagram represents the natural turf establishment cycle and demonstrates how the growth of natural grass fields "wakes up" later in the spring, well into the middle of a typical High School sports season. Using a natural turf field during this time places a significant amount of stress on the natural turf system and leads to a continuous and recurring conflict between field use for recreation and optimal growing conditions for natural turf.

Natural grass athletic fields, under ideal conditions, should be limited in the hours upon which they are played. This allows them to recuperate and allows for the grass to be maintained in a healthy and vigorous condition that adequately supports regular recreational use and meets the expectations of the users. Natural grass fields should not be played upon when wet, as this leads to soil compaction and turf damage. Ideally, they should also be "rested" (taking a field completely out of play for a season) to allow for full turf regeneration. These restrictions are not required for synthetic turf systems, which allow for greater use under less-than-optimal conditions (early spring/late fall, wet conditions, unlimited hours of use).

- ***Why can't all of Brookline's athletic fields be natural grass?***
  While all fields technically could be natural grass, Brookline has an existing shortage of fields, according to the 2020 Athletic Fields Needs Assessment and Master Plan. That study found that the average spring-to-fall usage of any given athletic field in Brookline is over 1,000 hours, not including walk-ins, casual day usage, or Green Dog off-leash program hours (which can add another 900 hours of use to many of the fields). The hours of use expected to be provided by Brookline's fields vastly exceeds industry standards for maintaining even fair turf quality conditions (see table below).

  Natural turf has certain limitations for continuous or intense athletic field use even with the implementation of highly sophisticated cultural maintenance practices by a turfgrass professional. The reality is that Brookline's athletic fields are:
  1. utilized in the early spring, before the grass is actively growing and rejuvenated from winter dormancy;
  2. expected to perform with little to no limitations on hours of use;
  3. never taken offline for a full growing season to allow for appropriate turfgrass recovery due to high demand across all field inventory. The exception to this is when a field is taken offline for a complete park renovation or redesign, such as the current Cypress Street Playground project.

  Synthetic turf fields help to bridge some of this burden, with no early spring or wet weather limitations or limitation on hours of use. It is one utensil in the tool kit to help the Town address its current supply (limited space) and demand challenges.

Expected Field Condition	Field Use (Hours per Year)
Sustained good field conditions	200 hours or less
Good Field conditions with some thinning of the turf and localized wear areas	400 to 600 hours
Fair field conditions; expect significant thinning and wear	800 to 1,000 hours
Significant turf loss, field surface damage, increased potential for athlete injury	More than 1,000 hours

(Maximizing the Durability of Athletic Fields, Grady L. Miller, North Carolina Cooperative Extension publication AG-726-W 01/2010 BS)

Table of field use hours and expected field conditions for natural turf fields

- ***What is the difference in environmental impact between synthetic and natural turf?***
  Synthetic turf is a man-made product and thus lacks soil and natural grass components. In addition, synthetic turf fields require the production of various manufactured materials that come with challenging and limited options for sustainable end-of-life disposal.
  In comparison, natural grass fields require a high number of on-going inputs for successful management and maintenance including fertilization, aeration, topdressing, overseeding/re-sodding, and irrigation. These are in addition to ongoing use of lawn mowers and string trimmers. It is also important to acknowledge that natural turf fields are *not* a true natural or native system. Successful natural turf athletic fields are often created using highly processed and often manufactured soils. Though they involve soil and living plants, the dominant and pervasive grasses that are utilized for natural turf athletic fields are not native to our geographic area. Some athletic fields include a blend of a few types of grasses, but most often represent a monoculture.

- ***What are the different types of infill materials?***
  As mentioned above, "infill" is the term used for the material that is placed between the synthetic turf fibers (or blades) during installation. Infill is a mixture of sand and other materials that acts as a ballast to hold down the turf, keep the turf blades vertical, provide shock attenuation and resiliency, and provide footing for the user or athlete. Many synthetic turf fields, including the one at Skyline Park, use a product called SBR (styrene-butadiene rubber) mixed with sand to form the infill layer between the grass blades. Most SBR rubber comes from ground, recycled tires. 25,000 to 30,000 ground tires are used in a typical field, rather than ending in landfills and incinerators. Though hundreds of scientific, peer-reviewed studies, as well as the EPA and Consumer Product Safety Commission, have found no health or environmental impacts from the use of SBR rubber in synthetic turf systems, negative public perceptions have resulted in the development of alternative infill options. Brookline has decided to no longer use SBR rubber infill.

  In recent years, Brookline as committed to no longer installing SBR for any synthetic turf fields. Newer synthetic turf fields installed in Brookline, such as Harry Downes Field and Ridley School, utilize an organic material/sand infill. The organic infill material is most often with walnut shells of pine tree shavings. Since organic infill products do not provide the same shock attenuating properties as SBR or virgin rubber and plastic infills, a "shock pad" (additional cushion layer) must be installed beneath the synthetic turf layer. Harry Downes Field and the field at Ridley School both utilize shock pads.

- ***What are PFAS and how do they relate to synthetic turf?***
  PFAS, known scientifically as per- and polyflouroalkyl substances, are man-made compounds that have been used in consumer products and industry since the 1940s. There are thousands of individual PFAS compounds. Many PFAS are water and oil resistant, are durable and do not degrade under natural conditions. Other PFAS are soluble and may degrade under typical natural conditions. These properties have resulted in PFAS being utilized in thousands of commercial daily use products including food packaging, cookware, and waterproof textiles used in jackets and shoes. Fire fighting foams (aqueous film forming foam or AFFF), surgical implants and water filtration equipment may also contain PFAS.

  Due to their presence in so many products and their environmental persistence, PFAS are now ubiquitous in the environment. PFAS has been detected in human blood, surface water sediments, surface and groundwater, rainfall and wildlife across the globe. Although the scientific research into PFAS is evolving, there is evidence there are adverse health effects associated with long-term exposure to some PFAS compounds.

  In the context of PFAS exposure, the USEPA and other regulatory agencies are primarily concerned with the effects of consuming soluble PFAS in drinking water. The Massachusetts Department of Environmental Protection (MassDEP) currently regulates six specific PFAS compounds in soil and drinking water. This group includes: perfluorooctanoic acid (PFOA), perfluorooctane sulfonic acid (PFOS), perfluorononanoic acid (PFNA), perfluorohexane sulfonic acid (PFHxS), and perfluorodecanoic acid (PFDA). These PFAS compounds are soluble in water and are shown to accumulate in in humans, animals and plants.

  Based on the limited research studies to date and what is known about the chemical composition of PFAS, dermal (skin) contact with PFAS containing materials is expected to pose minimal health risk. It is a component of many fabrics. Similarly, based on available research and chemical composition, most PFAS compounds do not appear to be volatile and are expected to pose minimal health risk through inhalation.

A number of municipalities in New England have engaged in synthetic turf sampling and analyses for PFAS, including the 6 PFAS compounds regulated by MassDEP. Low levels of soluble PFAS were reported in some synthetic turf system components. However, the concentrations of PFAS were similar to the "background" concentrations seen in soils in undeveloped lands. The PFAS concentrations in synthetic turf samples are not indicative of their use as a manufacturing additive, which would be expected at much higher concentrations. The research also indicates that there is not an increased risk of soluble PFAS exposure to humans or the environment due to synthetic turf fields.

However, synthetic turf does likely contain additives which are in the PFAS family. Synthetic turf grass is made by extruding a mixture of primarily polyethylene plastic into a mold shaped as blades of grass. Typically, a processing agent is utilized within the polyethylene mixture to assist with effective plastic injection and ease removing the blades from the mold. It is our understood that the predominant processing agent being used by the synthetic turf manufacturers is polyvinylidene fluoride-co-hexafluoropropylene (PVDF-HFP). PVDF-HFP is a polymeric PFAS. This copolymer is a very large molecule and not soluble in water. In addition, because the processing aid is mixed into the plastic being molded, it becomes bound into the polyethylene blade as part of the plastic matrix.

A review of the potential toxicity of PVDF-HFP does not reveal any relevant toxicity data. There is no reference to PVDF-HFP in EPA Integrated Risk Information Systems (IRIS) or the CDC's Agency for Toxic Substances and Disease Registry (ATSDR). This is likely because PVDF-HFP is considered inert. PVDF-HFP is a common component used in medical devices – stents, meshes, replacement joints, etc. Studies documented from Boston Scientific and others indicate PVDF-HFP is biocompatible, inert and insoluble. It appears to be very commonly used in medical devices. PVDF-HFP has many other common uses including food packaging and water purification (used within the plastic in water filters). Based on current information, high molecular weight fluoropolymers are believed to be too large to cross cell membranes and are therefore believed to pose less risk to human and ecological health relative to nonpolymer, soluble PFAS.

To our knowledge no other PFAS are being intentionally utilized in the manufacture of synthetic turf system components. Of the few synthetic turf companies we contacted, they indicate their products are now considered PFAS-free, recognizing the current issues with PFAS in synthetic turf.

PFAS regulations:

Consumer Products

No federal standards or regulatory limits are presently set for consumer products containing PFAS. Current regulations are limited to those stated above. The European Union regulates chemicals contained in consumer products via the Registration, Evaluation, Authorization and restriction of Chemicals (REACH) regulation. REACH is a European Union regulation (1907/2006/EC) restricting the levels of specific chemical substances in all imported goods. PFOS and PFOA are listed as restricted compounds by REACH. California Prop-65 provides a list containing a wide range of naturally occurring and synthetic chemicals that are known to cause cancer or birth defects or other reproductive harm. If a product contains chemicals on this list, a warning must be provided on the product. PFOA and PFOS have been on the Prop-65 list since 2017. As of December 31, 2021, PFNA and PFOS transformation and degradation precursors were added to the Prop-65 list.

Drinking Water

The USEPA has set a health advisory for perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) in drinking water of a sum total of 70 parts per trillion (ppt). Massachusetts Department of Environmental Protection (MassDEP) has developed drinking water standard of 20 ppt for the sum of six PFAS compounds (PFAS6) including both acid and anionic forms of the following:

- perfluorohexanesulfonic acid (PFHxS)
- perfluoroheptanoic acid (PFHpA)
- perfluorooctanesulfonic acid (PFOS)
- perfluorooctanoic acid (PFOA)
- perfluorononanoic acid (PFNA)
- perfluorodecanoic acid (PFDA)

Surface Water

Currently neither the USEPA nor MassDEP have set a surface water guidance/standard concentrations for PFAS. There is draft MADEP Method 1 GW-3 groundwater standards that are protective of migration of constituents in groundwater to nearby surface water bodies.

Soils

MassDEP has set standards for the PFAS6 in soil. Method 1 S-1/GW-1 concentrations are protective of potential leaching into groundwater and Method 1 S-1/GW-2&3 is protective of direct contact exposure. The table below summarizes the soil limits.

MADEP Soil Standards - parts per billion

PFAS	Leaching to Groundwater	Direct Contact
perfluorohexanesulfonic acid (PFHxS)	0.30	300
perfluoroheptanoic acid (PFHpA)	0.50	300
perfluorooctanesulfonic acid (PFOS)	0.72	300
perfluorooctanoic acid (PFOA)	2.00	300
perfluorononanoic acid (PFNA)	0.32	300
perfluorodecanoic acid (PFDA)	0.30	300

Is there synthetic turf without any PFAS?

All extruded plastic materials likely have polymer PFAS used as processing aids. However, many of the major synthetic turf manufacturers now have policy statements that declare they do not use soluble PFAS in the creation of their products. Many of the statements contain the following or similar wording:

"…do not use and PFAS chemicals currently listed as defined in EPA Method 537 and included in California Proposition 65, in or as part of the manufacturing process for the turf fibers, primary backings, urethane coatings or the assembly of any components of the system or system as a whole."

The EPA Test Method 537 and 533 report 24 to 30 individual PFAS compounds. No other standard laboratory test methods quantify individual PFAS. Using "Total Organofluorine" analyses will not report the actual concentrations of PFAS. These analyses report total organofluorine which does not correlate to a type or concentration of any individual PFAS. These tests do not discern between soluble PFAS, polymer PFAS or Non-PFAS related organofluorine. The total organic fluorine method is not standardized and can identify non-PFAS related fluorine.

One study performed testing for PFAS leaching from synthetic turf materials by submerging the materials in water that has been augmented to reflect typical rainwater in the northeast and stirs it for 24 hours. The water is then tested for PFAS. The results of these tests indicate that "estimated" or very low levels of PFAS6 and other individual PFAS leach from synthetic turf materials. These concentrations are well below the MADEP drinking water standard.

Destructive testing of synthetic turf components was also performed during the study (TOP Assay). This analysis exposes the materials being tested to a caustic acid and high heat (185 F) to breakdown "precursor" PFAS into PFAS that are measurable by the laboratory methods. The preparation of the sample does not represent natural conditions. Also, this is a very simplified description of the method and data interpretation. The TOP results reported 1 of the PFAS6 and 2 other PFAS at "estimated" concentrations. Thought these concentrations are well below the MADEP soil water standard.

Based upon the information reviewed to date, the following conclusions can be surmised:

- Individual PFAS compounds in synthetic turf were detected at concentrations generally below laboratory reporting limits in the synthetic turf system materials.
- The "estimated" PFAS concentrations in synthetic turf components are similar to background soil levels and are indicative of the ubiquitous nature of PFAS.
- The PFAS concentrations in synthetic turf are not indicative of their use as a manufacturing additive which would be expected at much higher concentrations.
- The PFAS concentrations in the synthetic turf are below published background concentrations in natural soils.
- Leaching testing of the synthetic turf system components indicate PFAS do not leach at concentrations near or above MassDEP drinking water regulation levels.
- Aggressive TOP assay testing reports "estimated", low levels of PFAS, similar to "background". This appears to indicate that the PFAS processing aid PVDF-HFP is not broken down into soluble PFAS, under the aggressive testing method conditions.

The Town's technical specifications for all future synthetic turf projects would include language stating that all turf system manufacturers shall provide detailed information regarding use of any PFAS in their products and attestation that manufacture of their products does not use regulated PFAS compounds. In addition, the specifications will require testing of the actual batches of materials to be utilized at our projects for individual PFAS using compound specific analyses.

- ***Is heat a concern with synthetic turf fields?***
  Yes, heat is a concern with synthetic turf fields. When exposed to direct summer sunlight, synthetic turf fields are hotter than natural turf fields. In Brookline, this is primarily an issue on the sunniest and hottest days in July and August, but can be greatly influenced by wind, cloud cover and humidity. During times of extreme heat, synthetic turf field use should be

staggered outside of prime sun exposure, and conducted in accordance with the National Athletic Trainers Association's heat-acclimation guidance. For most of the spring and fall, use of synthetic turf fields in Brookline is not an issue. It is also important to note that synthetic turf fields with organic infill systems (like Harry Downes and Ridley), can help to significantly reduce surfaces temperatures. Since organic infills have moisture retention qualities, they can cool fields by 20+ degrees via evapotranspiration. Heat concerns are generally less of an issue during spring and fall sports seasons.

- ***How is synthetic turf recycled?***
  Currently, there is no dedicated synthetic turf recycling facility in the United States, nor does Massachusetts have specific regulations for recycling or disposal. Quoting from a July 22, 2021 article in the Salem News, "*A spokesman for the Massachusetts Department of Environmental Protection said the state does not have specific regulations regarding the disposal of artificial turf. The materials must be disposed of or recycled following waste disposal regulations like any other waste material…*" There are, however, private companies that are in the business of recycling synthetic turf, such as *Artificial Grass Recyclers Turfcycle USA.* These companies find additional uses for turf that has been formerly used and reached the end of its life in a particular setting, but still has viable use elsewhere.

  RE-Match Turf Recycling is an actual synthetic turf recycling company, but has facilities only in Europe. They are actively working on the development of a recycling facility in the United States. The Commonwealth of Pennsylvania has recently committed a substantial amount of capital to the development of an in-state turf recycling facility (https://www.timesleader.com/news/1526774/gov-wolf-announces-40-jobs-coming-to-re-match-in-hanover-twosnhip).

  Brookline's technical specifications for all future synthetic turf projects will include language requiring chain of custody documentation indicating where and how the various synthetic turf field components will be recycled and/or re-purposed.

- ***How do natural versus synthetic turf fields compare for maintenance?***
  The maintenance required on any athletic field is driven by the amount of usage the field receives regardless of whether it is synthetic or natural. Natural grass fields, as a living system, require additional maintenance considerations that do not apply to synthetic fields. Inputs to allow natural grass fields to thrive and recover from use include soil fertility, water supply (rain and irrigation), frequent mowing, aerification, periodic topdressing, consistent introduction of new seed to replace damaged plants, and pest management when needed (weeds, insects, disease). As mentioned above, an important aspect of field maintenance that is often overlooked is allowing a natural grass field to rest (no use for several weeks). This improves the grass plants' ability to recover and allows newly introduced seed the ability to germinate, develop a sufficient root system, and grow to a suitable density to sustain use.
  Synthetic fields, based on the same amount of usage as a natural field, require significantly less maintenance in general. This maintenance includes field grooming to re-disperse infill material and infill screening to remove debris and reduce compaction. Additional infrequent maintenance required for synthetic fields would include monitoring and addition of new infill material due to loss or decay (organic infills).

- ***What is the cost of installation for a synthetic turf field compared to a natural turf field?***
  As part of the *2020 Athletic Fields Needs Assessment and Master Plan*, a comparison of costs between a natural grass field and synthetic turf field was compiled by Town staff. Using data from recent previous Town projects, it was determined that the cost to install a typical natural grass field of around two (2) acres was estimated at $500,000. The cost of a

similar sized synthetic surface was estimated at $1,400,000. These costs were then extrapolated to include maintenance and capital costs over a 20-year period. The average annual capital plus maintenance costs worked out to $87,875 per year for a natural turf field, and $103, 483 per year for a synthetic turf field. This data was further extrapolated to look at a cost per use. The natural turf field, at recommended hours per use per year equated to about $198; the synthetic turf field $64.

The Institute of Sports Field Management with the New England Sports Turf Managers Association has also researched these costs for comparison purposes. They report the costs for a synthetic field are in the $6.00 – $10.25/sq. ft. range. The cost of a natural grass field is dependent on the soil profile used for its construction. A native-soil field (on-site materials) costs about $.60 - $1.50/sq. ft. When a native soil field is constructed with off-site materials, the range is $1.50 - $3.00/sq. ft. A sand-based root zone mix field costs about $2.75 - $4.00/sq. ft. and a true sand-based field (often yielding the highest level of performance and potentially more hours of use) is estimated at a range from $5.50 - $8.00/sq. ft. A typical size athletic field, for estimating purposes, encompasses about 80,000 sq. ft. (about 1.8 acres)

- ***Where does Brookline have Synthetic Turf Athletic Fields and what are they made of?*** The Town of Brookline currently has a synthetic turf fields at Skyline Park, Soule Recreation (lower field), Harry Downes Field, and the Ridley School. Once completed, the new Driscoll School will also contain a synthetic turf field.

Field Name	Install Year	Field Details	Turf Manufacturer
Skyline Park	2007	Synthetic turf field with sand/ SBR rubber infill over stone subbase with underdrains	FieldTurf
Soule Recreation	2011	Synthetic turf field with sand/ SBR rubber infill over stone subbase with underdrains	Field Turf
Harry Downes	2019	Synthetic turf field with sand/ organic infill over shock pad over stone subbase with underdrains. Synthetic turf carpet and shock pad were replaced in 2019 over existing subbase, previously installed.	GreensFields
Ridley School	2020	Synthetic turf field with sand/ organic infill over shock pad over stone subbase with underdrains.	Shaw

- ***Do Synthetic Turf Fields Cause Cancer?***
In 2015, a story aired on NBC Nightly news about synthetic turf causing cancer in soccer goalies, gaining wide attention across news services. This story was based upon a list of soccer goalies in the Washington State area, collected by soccer coach Amy Griffin at the University of Washington. These concerns were focused on crumb rubber infilled synthetic

turf fields and her speculation that they were related to the cancer cases of these goalies. The Washington State Department of Health subsequently performed a study in April 2017 titled "Investigations of Reported Cancer among Soccer Players in Washington State." (see https://doh.wa.gov/sites/default/files/legacy/Documents/Pubs//210-091.pdf) Their conclusion states: "This investigation found less cancer among the soccer players, select and premier players, and goalkeepers on the coach's list than expected based on rates of cancer among Washington residents of the same ages. In addition, the currently available research on the health effects of artificial turf does not suggest that artificial turf presents a significant public health risk. Assurances of the safety of artificial turf, however, are limited by lack of adequate information on potential toxicity and exposure."

Much of the debate about the danger of synthetic turf concerns the bioaccessibility of the contaminants in crumb rubber infill—whether the contaminant is likely to be absorbed into the body. A 2013 study in *Risk Analysis* indicated that PAHs in artificial turf were generally below the limit of detection. The study characterized the exposure as generally "de minimus" A 2013 review of evidence indicated that the total risk of absorption through oral exposure, skin absorption, or inhalation for athletes was insignificant, concluding that "elevated health risk from inhalation exposure could occur only for workers installing artificial turf in small and poorly ventilated facilitates with a long exposure history" (*Environ. Sci. Technol.* 2014)

As stated above, Brookline has committed to ***not*** utilizing crumb rubber infill as a component of any new or replacement synthetic turf fields. Much of the research available on synthetic turf fields are on those that use crumb rubber as an infill, however there is little research on synthetic turf fields with organic infill. The research with synthetic fields with crumb rubber includes state (MA DEP) and federal (USEPA), with numerous other scientific studies available. The USEPA research (2019) concluded, "In general, the findings from the report support the premise that while chemicals are present as expected in the tire crumb rubber, human exposure appears to be limited based on what is released into air or simulated biological fluids (gastric fluid, saliva and sweat)." The MA DEP web site indicates: "To date, scientific research mostly concludes that adverse health effects from using ATF (Artificial Turf Fields) are unlikely."

- ***Do Synthetic Turf Fields contaminate groundwater?***
  Similar to the question above, much of the research available today relative to this topic, relates to synthetic turf fields with crumb rubber. A July 2010 titled "Artificial Turf Study: Leachate and Stormwater Characteristics" was conducted by the Connecticut Department of Environmental Protection. (See https://portal.ct.gov/-/media/DEEP/artificialturf/DEPArtificialTurfReportpdf.pdf) The fields studied were synthetic turf fields with crumb rubber infill. Stated in their conclusions, "This study did not identify any significant risks to groundwater protection criteria in the stormwater runoff from artificial turf fields. It is important to note, that the DEP study did not directly collect and analyze groundwater at these artificial turf fields. Consequently, this conclusion regarding consistency with groundwater protection criteria is an extrapolation of the stormwater results collected and the evaluation of data presented in recent studies, such as Nillson et al (2008) and Lim et al (2009)."
  To date, no peer reviewed research relates synthetic turf fields to PFAS contamination of groundwater. The Toxics Use Reduction Institute of UMass Lowell provides a fact sheet on PFAS and synthetic turf. (see https://www.turi.org/content/download/12963/201149/file/TURI+fact+sheet+-+PFAS+in+artificial+turf.pdf) There is no finding listed in this fact sheet that indicates synthetic turf contributes to PFAS contamination of groundwater.